ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, *JULY* 26 *TO AUGUST* 1

(For the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on July 26

Sun rises, 4h. 17m.; souths, 12h. 6m. 14·3s.; sets, 19h. 55m.; decl. on meridian, 19° 22′ N.: Sidereal Time at Sunset, 16h. 14m.

Moon (Full on July 27) rises, 19h. 15m.; souths, 23h. 58m.; sets, 4h. 46m.*; decl. on meridian, 15° 30′ S.

Planet	Rises	Souths	Sets	Decl. on meridian
	h. m.	h. m.	h. m.	° ′
Mercury	6 39	13 46	20 53	12 10 N.
Venus	6 18	13 37	20 56	14 19 N.
Mars	1 8	9 26	17 44	23 41 N.
Jupiter	7 25	14 19	21 13	9 52 N.
Saturn	1 44	9 54	18 4	22 31 N.

* Indicates that the setting is that of the following day.

Phenomena of Jupiter's Satellites

July	h. m.		July	h. m.	
29	20 57	II. tr. ing.	31	19 49	II. ecl. reap.
30	20 9	I. occ. disap.			

The Phenomena of Jupiter's Satellites are such as are visible at Greenwich.

July	h.	
26	7	Mercury in conjunction with and 0° 12′ south of Regulus.

GEOGRAPHICAL NOTES

The Rev. G. Grenfell has recently explored the Mobangi, which enters the right bank of the Congo, forming a great delta, between 26′ and 42′ S. lat., nearly opposite Equator Station, and is probably its greatest tributary. Mr. Grenfell navigated the Mobangi in the little steamer *Peace*, on a mean course of north by east, from the equator to 4° 30′ N. lat., and left it still an open waterway. At 4° 23′ N., just below the second rapids, he found it 673 yards wide; at no point lower was it less in width. Its mean depth is 25 feet, and although the current runs not more than 80 to 100 feet per minute, it means an immense volume of water to find running south at a point, as Mr. Grenfell puts it, so near the supposed sources of the Binné, the great affluent of the Niger. Where does it all comes from? he asks. The "trumbashes" of the Chad Basin (Schweinfurth) are common, while they are not known on the Congo. The opinion of Mr. Grenfell and of his Congo colleagues, we believe, is that the Mobangi is probably the lower part of the Welle, a river whose course is one of the unsolved problems of African geography. This is certainly a more likely solution than to connect the Welle with the useless Aruwimi, as Stanley is inclined to do. From the notes sent home by Mr. Grenfell, it would seem that the Mobangi is navigable the whole way from the Congo to 4° 30′ N., a distance of probably 400 to 450 miles, taking account of the bends. A large map, in ten sheets, of the explored part of the river has just been received at the Royal Geographical Society. It is hoped that a full narrative of Mr. Grenfell's explorations will reach England in time to be read at the Aberdeen meeting of the British Association. The Mobangi, Mr. Grenfell writes, is far more populous than any equal length of the Congo, and to his mind the country is more promising. Whether the Mobangi is the Welle or not, it must form an important connecting link between the basin of the Congo and the basins of the Niger, the Shari, and the Nile. Mr. Stanley has always maintained that the region lying between the Congo and the Nile is probably the richest and most promising in Africa, and his belief seems likely to be amply confirmed. Besides the Mobangi, Mr. Grenfell has explored 300 miles of river courses debouching into the Congo, and, as he is a trained and careful surveyor, he will be able to plot them with precision. The most northerly point of the Congo bend he found to be 2° 11′ N. lat., near the mouth of the Ukere or Dujangi.

At the last meeting of the French Geographical Society, held on Friday night, M. Ferdinand de Lesseps gave an account of the recent success of the operations conducted with the object of finding water in the desert tracts of Southern Tunis. After the death of Col. Roudaire the French Minister of War authorised Commandant Landais to resign his duties at the Military School at Saint Cyr, in order that he might continue the schemes set on foot in the region of the Tunisian Shotts. At this time those who believed in the success of these undertakings directed their attention chiefly to the establishment of a harbour at Gabes. The necessity for a port where vessels could put in on the southern coast, and for a town through which the traffic of Tunis and Tripoli could be conducted, was apparent. It was determined to commence operations at the mouth of the Wady Melah, and to make the station established at this point the basis of future and more extensive operations. Two years ago M. de Lesseps, in company with M. Roudaire, visited the region of the Shotts. They observed there, on the banks of the Wady Melah, a lake in which the level of the water never sinks. This water was excellent. M. de Lesseps thought, although there was no visible confirmation of the fact, that this water might be in communication with a deep sheet of water. In consequence he requested the engineers to make borings, or to sink a well at that spot. They have succeeded admirably. At a depth of 91 metres they reached the sheet of water sought for. The flood rushed from the ground with such velocity that it raised with it stones weighing 12 kilogrammes, and threw them to a great height into the air. The well yields 8000 cubic metres of water a minute.

ANNUAL REPORT OF THE FISHERY BOARD FOR SCOTLAND, 1884

The third Report of the New Fishery Board for Scotland, which was recently presented to Parliament, contains, amongst other useful information, valuable statistics of the fish captured during 1884, and a record of the scientific work carried on under the direction of Prof. Ewart, the energetic convener of the Scientific Committee of the Board. From the Report it appears that the herring fishing of 1884 was the most abundant ever known. Unfortunately, it was largely composed of immature and small fish, and consequently it was of much less value than it would otherwise have been. Great shoals of young herrings were found far out at sea much earlier than usual, and heavy takes were made before they had time to mature. The curers were often unable to overtake the hauls of mature fish, and hence much good food was wasted. The haddock and sprat fishings were also successful, and large quantities of halibuts were taken off Shetland. The salmon fishing was not so productive as in 1883, which was a singularly good year. The most important fish taken and sold fresh is the haddock, of which the value is nearly three times as great as any of the others. The total estimated value of the white fish amounted to 716,295*l.*, and of the shell-fish, 80,939*l.* Beam trawling was carried on to a much greater extent than formerly, and with a fair amount of success. Telegraphic communication has been extended to the fishery stations at Castle Bay, Island of Barra, St. Mary's Burra, St. Margaret Hope, Orkney, Reawick, and Vaila Sound (Walls), Shetland, and this is much appreciated by the fishermen and other persons engaged in the fishing industry. Several harbours have also received grants to aid in construction or improvement. The Board, having recognised that great progress had been made in practical fish-culture in America, requested Prof. Cossar Ewart to visit Canada and the United States and report on the methods adopted there for improving the fisheries. Prof. Ewart accordingly visited first the fish-hatching stations in Canada, and afterwards the principal fishing-stations and laboratories of the United States Fish Commission. In addition to visiting the central station and the carp ponds in Washington, Prof. Ewart was able to study the appliances for carrying on hatching and other operations at Wood's Holl. He also visited the Bucksport and other stations for hatching salmon and trout, studied the arrangements for receiving and preserving fresh fish at Gloucester, Boston, and New York, and the methods of utilising the by-products of the fisheries. He likewise examined the boats and fishing appliances in use among the American fishermen and also the splendid vessel *Albatross*, recently constructed for the scientific work of the Fish Commission. It seems the Commission considers that "the best policy is to expend a small amount of public money in making fish so abundant by artificial means that they can be got without restriction and serve as cheap food for the people at large, rather than to expend a much larger amount in trying to prevent people from catching the few which remain after years of improvidence." In order to carry on investigations and hatching operations on the lines which have proved so successful in America, the Board will require to be provided with (1) a well-equipped laboratory with suitable hatching-tanks and at least one large sea-water pond; (2) a cruiser adapted for carrying on dredging and other operations; (3) two small steam tenders adapted for inshore work; (4) a sufficient annual sum of money to meet the working expenses of hatching and other operations and to provide the necessary apparatus. From information gained in America the Board feels that, if provided with sufficient funds and with increased powers, it might be able greatly to increase the number of useful food fishes in the firths, bays, and other waters around the coast. The marine station at St. Andrews is now in working order and an assistant naturalist has been sent to carry on investigations under the direction of Prof. McIntosh, F.R.S. A number of interesting inquiries have been instituted, especially on the nature of the eggs and rate of growth of fishes and the life-history of the common mussel. The Scientific Committee, who felt the assistance of an experienced naturalist devoting his whole time to the work of inquiry to be not merely expedient but necessary, have been so fortunate as to secure the services of Mr. Brook, F.L.S., of Huddersfield, who had been studying for some time the history and habits of fish, and gained considerable experience in organising and carrying on a marine laboratory. A temporary laboratory has been erected at East Tarbert, a convenient situation for studying the west coast fishing and from which it is possible to study not only the herring-fishing in Loch Fyne, but, with a good steamboat, to embrace the whole area of the Firth of Clyde. Mr. Brook is engaged in studying the development of the herring, and the result of his experiments will be described in detail in papers the first of which is now appended—the others to be presented to the Board in the autumn. Mr. Brook has also in hand a paper on the "Food of the Herring," to be completed in the autumn. The Directors of the Rothesay Aquarium have very kindly placed the tanks of their institution at the service of the Board, and this will be of great assistance in the study of the life-history of various food fishes, especially during the winter months. There is now at the service of the Board a small laboratory in the Cromarty Firth, and it is hoped that a marine laboratory may soon be established near the mouth of the Firth of Forth.

The most important paper in the scientific appendices contains "Observations on the Spawning of the Cod," by Prof. Cossar Ewart and Mr. George Brook. The authors say that it is now twenty years since G. O. Sars discovered, what our fishermen still decline to believe, that the eggs of the cod float on the surface of the sea, and only sink when dead. Sars's after-investigations showed that the eggs and the milt are of less specific gravity than the sea water, and consequently float, also that the micropyle lies near the lower portion of the egg. The experiments reported were carried on in Rothesay Aquarium on fish which had been in the tanks for four years. In February several cod appeared to be reaching maturity; early in March the fish refused food, and a few days afterwards eggs in an early stage of development were floating on the surface of the water, so abundantly that hundreds were collected in a few minutes by means of a piece of muslin placed over the overflow of the tanks. The temperature of the water was 43° F., and the specific gravity a little over 1·024. The eggs were usually found during the first few days in from the 2- to 8-cell stage at 8 a.m., so that they were most probably shed about daybreak. Later batches shed between 6 and 7.30 p.m. were found at the latter hour with the disk already forming. The great transparency of the living eggs makes it almost impossible to notice them as they rise through the water, whilst the dead eggs, being slightly opaque, are easily recognised as they are carried to and fro by the currents. For some time before the first eggs reach maturity, and during the early part of the spawning period, the fish not only refuse food, but give up their regular movements around the tank and swim about in small groups or rest together at the bottom, swimming and resting alternately. Sometimes a single female would swim leisurely about for a few minutes attended by a single male, and often settle down in a corner of the tank and rest till disturbed by her attendant. The activity of the males was specially evident at dusk and in the early morning, and it was apparently during these periods of activity that the eggs were shed and fertilised. One day, for example, there were no eggs visible on the surface of the water at 6 p.m., while a considerable number were obtained at 7.30, which, as the germinal disk was not completely formed, had in all probability been quite recently shed while the fish had been swimming about the tank in groups. From the observations made, it seems, as suggested by Sars, that the eggs and milt are shed while the fish are swimming freely about in the water. The males swim indiscriminately among the females, sometimes over, sometimes under them, fertilising the water through which the shed eggs are slowly rising to the surface. Eggs were pressed from a ripe female and fertilised artificially. They developed normally, but it was found that a few kept for some hours in a small glass cell in a warm room, for observation under the microscope, began to show similar abnormalities to those figured by Ryder ("Embryology of Osseous Fishes," Report U.S. Fish Commission, 1882). Too high a temperature has a similar effect on other eggs, but those which float on the surface are naturally more sensitive. The females, like the Salmonidæ, are capable of withholding the flow of ripe eggs to a certain extent. A limited number only are ripe at one time, and if the unripe be forced out they sink to the bottom and are incapable of being fertilised. The ripe unfertilised egg has a milky appearance and is moreover not so transparent as the fertilised one, so that by a little practice the two can be distinguished without the aid of a microscope. As soon as an egg begins to die or to develop abnormally, the milkiness returns and it sinks to the bottom. Whether fertilised or not, the eggs float immediately after extrusion, but in the latter case they die and sink to the bottom in twelve to fourteen hours. During this time no change was observed to take place in the unfertilised egg, the small oil-vesicles around the yolk remaining constantly in their primitive condition. In perfectly still water (sp. 1·024) the eggs float in a dense mass; when carried along by a strong current they become suspended at various depths, but none that are living lie at the bottom. At any rate all found there were either dead or dying. It seems that large numbers of the pelagic fish eggs have been dredged at the Fishery Board Station at Tarbet. With the sea perfectly calm, most eggs were obtained on the surface; with a slight ripple the net had to be kept just under the surface and in other states of the weather to be lowered two or three feet under the surface. The eggs having a specific gravity only slightly less than that of water, do not rise to the surface very rapidly. In one case noted it took an egg four minutes to rise through 1¼ inches of water. The milt also has less specific gravity than sea-water, and rises to the surface when shed. If forced down, it gradually rises again, disseminating as it does so. During the spawning process the water in the tank became slightly clouded by the spermatazoa, which were spread through it. The milt is, however, shed in such a thin stream under natural conditions that it is difficult to detect it. The eggs are capable of being fertilised a considerable time after the fish is dead, and also some time after they have been shed. Light appears to have considerable influence on the spawning process, and under natural conditions the eggs seem to be shed at daybreak or dusk, when the light is not strong. The observations made justify the conclusion that the spawn is shed while the fishes are swimming about freely in the water, and that the eggs are fertilised at, or as they rise to the surface, this being facilitated by the position of the micropyle, which is always found in the lower hemisphere of pelagic fish ova. To show the facility with which some fish ova are fertilised, an experiment on herring ova may be here mentioned. Three batches of ova secured from a living female were placed in tumblers, and water added from an adjoining tank. It was intended to fertilise each batch separately, and at fixed intervals, but it was found that though no milt had been intentionally added to the second or third tumblers, the water not being from the tank in which the herring were kept, spermatozoa must have been introduced with the water, as the second and third batch of eggs developed exactly like the first, and were ultimately hatched out. As Kupfer points out, it is necessary, in order to keep eggs unfertilised, to get a fresh supply of water direct from the sea.

Mr. Brook's first paper on the "Development of the Herring" gives a *résumé* of what is already known on the subject, as preliminary to the result of his own investigations. He also sends notes of rare and curious fishes sent to the Board. Dr. M'Intosh details the work done by himself and by his scientific visitors to the St. Andrew's Laboratory. Prof. Cossar Ewart reports on the progress of Fish-culture in America, and Mr. Young on the Northern and Western Salmon Rivers. The Report is both interesting and encouraging. It is difficult to form an adequate idea of the immense importance of their sea-fisheries to the people of Scotland. But it may be stated that about half a million of people, or about one-seventh of the entire population of Scotland, are connected with this industry, and more or less dependent upon it. Happily the country is now beginning to realise the importance of the matter, and when the Government places at the disposal of the Board sufficient money to carry on the necessary investigations, the produce of the Scottish fisheries, great as it now is, may be still largely increased.

RADIANT MATTER SPECTROSCOPY

THE following paper on this subject was read by Mr. Crookes at the Royal Society, June 18:—

In the concluding sentence of the Bakerian lecture which I had the honour to deliver before the Royal Society, May 31, 1883, I said that the new method of radiant matter spectroscopy there described had given me not only spectrum indications of the presence of yttrium as an almost invariable, though very minute, constituent of a large number of minerals, but had likewise revealed signs of another spectrum-yielding element. I stated that I had repeatedly seen indications of another very beautiful spectrum characterised by a strong red and a double orange band.

Elimination of Mercury Vapour from Vacuum Tubes.—It is much more difficult than is generally supposed to keep mercury vapour from diffusing into the experimental tubes.

The following plan answers perfectly so far as my experiments have yet gone:—Sulphur is first prepared by keeping it fused at a high temperature till bubbles cease to come off, so as to get rid of water and hydrogen compounds. It is then allowed to cool, and is pounded and sifted so as to get it in the form of granules averaging a millimetre in diameter. A glass tube, a centimetre in diameter and about 2 feet long, is lightly packed for half its length with this sulphur, and next about 2 inches of iodide of sulphur (I_2S_2) is added, and the rest of the tube is then filled up with sulphur. Ignited asbestos is packed in at each end to keep the sulphur from blowing out whilst the vacuum is being made, or from being sucked through when air is suddenly let in. This contrivance entirely keeps mercury vapour from passing through, since the iodide of sulphur holds its iodine very loosely, and fixes the mercury in the form of non-volatile red iodide. A glass tube containing finely-divided copper must follow in order to keep the sulphur out. With this blockade interposed between the pump and experimental tubes I have been unable to detect mercury vapour in any of the tubes, whether in the cold or on heating them.

The "Orange Band" Spectrum.—Since the date of my last paper I have devoted myself to the task of solving the problem presented by the double orange band first observed in 1881. With the yttrium experience as a guide it might be thought that this would not be a difficult task, but in truth it helped me little beyond increasing my confidence that the new, like the old spectrum, was characteristic of an element. The extreme sensitiveness of the test is a drawback rather than a help. To the inexperienced eye one part of "orange band" substance in ten thousand gives as good an indication as one part in ten, and by far the greater part of the chemical work undertaken in the hunt for the spectrum-forming element has been performed upon material which later knowledge shows does not contain sufficient to respond to any known chemical test.

Chemistry, except in few instances, as water-analysis and the detection of poisons, where necessity has stimulated minute research, takes little account of "traces;" and when an analysis adds up to 99·99, the odd 0·01 per cent. is conveniently put down to "impurities," "loss," or "errors of analysis." When, however, the 99·99 per cent. constitutes the impurity and this exiguous 0·01 is the precious material to be extracted, and when, moreover, its chemistry is absolutely unknown, the difficulties of the problem become enormously enhanced. Insolubility as ordinarily understood, is a fiction, and separation by precipitants is nearly impossible. A new chemistry has to be slowly built up, taking for data uncertain and deceptive indications, marred by the interfering power of mass in withdrawing soluble salts from a solution, and by the solubility of nearly all precipitates in water or in ammoniacal salts, when present in traces only. What is here meant by "traces" will be better understood if I give an instance. After six months' work I obtained the earth didymia in a state which most chemists would call absolutely pure, for it contained probably not more than one part of impurity in five hundred thousand parts of didymia. But this one part in half a million profoundly altered the character of didymia from a radiant matter spectroscopic point of view, and the persistence of this very minute quantity of interfering impurity entailed another six months' extra labour to eliminate these final "traces," and to ascertain the real reaction of didymia pure and simple.

Chemistry of the Orange Band-forming Substance.—At first it was necessary to take stock, as it were, of all the facts regarding the supposed new substance, provisionally termed *x*, which had turned up during the search for the orange band. In the first place *x* is almost as widely distributed as yttria, frequently occurring with the latter earth. It is almost certainly one of the earthy metals, as it occurs in the insoluble oxalates, in the insoluble double sulphates, and in the precipitate with ammonia. It is not precipitated by sodic thiosulphate, and moreover it must be present in very minute quantities, since the ammonia precipitate is always extremely small, and as a rule *x* is not found in the filtrate from this precipitate.

At this stage of the inquiry the chemical reactions of *x* were much more puzzling than with yttria. At the outset an anomaly presented itself. The orange band was prone to vanish in a puzzling manner. Frequently an accumulation of precipitates tolerably rich in *x* was worked up for purposes of concentration, when the spectrum reaction suddenly disappeared, showing itself neither in precipitate or filtrate; whilst on other occasions, when following apparently the same procedure, the orange band became intensified and concentrated with no apparent loss. The behaviour of the sulphate to water was also very contradictory; on some occasions it appeared to be almost insoluble, whilst occasionally it dissolved in water readily.

Is "x" a Mixture?—A very large series of experiments, which need not here be described in detail, resulted ultimately in establishing the remarkable fact that the *x* I sought was an earth which of itself could give no phosphorescent spectrum in the radiant matter tube, but became immediately endowed with this property by admixture with some other substance, which substance likewise by itself had no power of phosphorescing with a discontinuous spectrum.

"x" in Cerite.—In the corresponding yttrium research I was aided materially by the fact that the sought for earth did not give an absorption spectrum. This enabled me to throw out a large number of obscurely known elements, and I therefore early endeavoured to ascertain whether the supposed new earth, *x*, did or did not give an absorption spectrum. Gradually it was noticed that whenever the didymium absorption bands were strong, the orange band spectrum was also particularly brilliant. Moreover, amongst the earths previously enumerated as mixed with lime in the quest for *x*, I have mentioned that some of them gave the orange band spectrum with increased intensity; the earths of the cerium group were the most noteworthy, and these considerations made it probable that here would be found the location of *x*.

Analysis of Cerite.—The cerium group consists of cerium, lanthanum, didymium, and samarium.

The first necessity was to get the earths ceria, lanthana, and the mixture hitherto called didymia, in a pure state; for my so-called pure earths of this group all showed the orange band in more or less degree.

The separation from each other of ceria, lanthana, didymia, and samaria is a most laborious process, and the amounts of these earths, obtainable in anything like a pure state, is small, compared with the mass of material worked up. Full particulars are given in the paper as to the method adopted to obtain each of them in a state of purity.

Ceria.—The ceric oxide obtained was almost pure white. A considerable thickness of a strong solution did not show a trace of absorption spectrum. The atomic weight of the metal was taken and yielded the number 141·1.

The ceric oxide gave no orange band spectrum in the radiant matter tube, either with or without the addition of lime.

Lanthana.—Lanthana is more difficult to purify than ceria. Long after the lanthana appeared pure it gave in the radiant matter tube a good orange band spectrum when mixed with lime and treated as usual, although without lime it gave no spectrum. Ultimately, however, a lanthana was obtained which, mixed with lime and treated in the usual manner, gave no orange band spectrum whatever. This lanthana was snow-white, and had an atomic weight of 138·3.

Didymia.—The earth formerly called didymia is now known to be a mixture of didymia and samaria, and systematic operations were now commenced with the object of obtaining the didymia and the samaria in a state of purity—that is to say, in such a condition that one of them should show no orange band